WHAT IS CLAIMED IS:

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1. A gain medium comprising:

a concentrated solid including a plurality of semiconductor nanocrystals, wherein the concentrated solid is substantially free of defects.

2. The gain medium of claim 1, wherein the solid includes greater than 0.2% by volume of semiconductor nanocrystals.

3. The gain medium of claim 1, wherein the solid includes greater than 10% by volume of semiconductor nanocrystals.

4. The gain medium of claim 1, wherein each of the plurality of semiconductor nanocrystals includes a same or different first semiconductor material selected from the group consisting of a Group II-VI compound, a Group II-V compound, a Group III-VI compound, a Group III-V compound, a Group IV-VI compound, a Group I-III-VI compound, a Group II-IV-VI compound, and a Group II-IV-V compound.

5. The gain medium of claim 4, wherein each first semiconductor material is selected from the group consisting of ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TlN, TlP, TlAs, TlSb, PbS, PbSe, PbTe, and mixtures thereof.

6. The gain medium of claim 4, wherein each first semiconductor material is overcoated with a second semiconductor material.

7. The gain medium of claim 6, wherein second semiconductor material is ZnO, ZnS, ZnSe, ZnTe, CdO, CdS, CdSe, CdTe, MgO, MgS, MgSe, MgTe, HgO, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, InN, InP, InAs, InSb, TlN, TlP, TlAs, TlSb, TlSb, PbS, PbSe, PbTe, or mixtures thereof.

8. The gain medium of claim 6, wherein each first semiconductor material has a first band gap and each second semiconductor material has a second band gap that is larger than the first band gap.

9. The gain medium of claim 1, wherein each nanocrystal has a diameter of less than about 10 nanometers.

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10. The gain medium of claim 1, wherein the plurality of nanocrystals have a monodisperse distribution of sizes.

11. The gain medium of claim 1, wherein the plurality of nanocrystals include a plurality of monodisperse distribution of sizes.

12. The gain medium of claim 1, wherein the concentrated solid of nanocrystals is disposed on a substrate.

13. The gain medium of claim 12, wherein the substrate is glass and the concentrated solid of nanocrystals has a thickness greater than about 0.2 microns.

14. A gain medium comprising:

a concentrated solid including a plurality of semiconductor nanocrystals, wherein the concentrated solid is capable of providing gain to an optical signal greater than about 25 (cm^{-1}) and the maximum gain occurs at an energy equal to or less than the maximum band gap emission of the nanocrystals.

15. The gain medium of claim 14, wherein the concentrated solid is capable of providing gain to an optical signal greater than about 50 (cm^{-1}).

16. The gain medium of claim 14, wherein each of the plurality of semiconductor nanocrystals includes a same or different first semiconductor material selected from the group consisting of a Group II-VI compound, a Group II-V compound, a Group III-VI

compound, a Group III-V compound, a Group IV-VI compound, a Group I-III-VI compound, a Group II-IV-VI compound, and a Group II-IV-V compound.

D' cont'd

17. The gain medium of claim 16, wherein each first semiconductor material is selected from the group consisting of ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TlN, TlP, TlAs, TlSb, PbS, PbSe, PbTe, and mixtures thereof.

18. The gain medium of claim 16, wherein each first semiconductor material is overcoated with a second semiconductor material.

19. The gain medium of claim 18, wherein second semiconductor material is ZnO, ZnS, ZnSe, ZnTe, CdO, CdS, CdSe, CdTe, MgO, MgS, MgSe, MgTe, HgO, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, InN, InP, InAs, InSb, TlN, TlP, TlAs, TlSb, TlSb, PbS, PbSe, PbTe, or mixtures thereof.

20. The gain medium of claim 18, wherein each first semiconductor material has a first band gap and each second semiconductor material has a second band gap that is larger than the first band gap.

21. The gain medium of claim 14, wherein each nanocrystal has a diameter of less than about 10 nanometers.

22. The gain medium of claim 14, wherein the plurality of nanocrystals have a monodisperse distribution of sizes.

23. A gain medium comprising:

a concentrated solid including a plurality of semiconductor nanocrystals, wherein a concentrated solid is capable of providing gain at energies in which a concentrated solid is substantially free of absorption.

24. The gain medium of claim 23, wherein each of the plurality of semiconductor nanocrystals includes a same or different first semiconductor material selected from the

group consisting of a Group II-VI compound, a Group II-V compound, a Group III-VI compound, a Group III-V compound, a Group IV-VI compound, a Group I-III-VI compound, a Group II-IV-VI compound, and a Group II-IV-V compound.

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25. The gain medium of claim 24, wherein each first semiconductor material is selected from the group consisting of ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgS, HgSe, HgTe, AlN, AlP, AlAs, AlSb, GaN, GaP, GaAs, GaSb, GaSe, InN, InP, InAs, InSb, TlN, TlP, TlAs, TlSb, PbS, PbSe, PbTe, and mixtures thereof.

26. The gain medium of claim 24, wherein each first semiconductor material is overcoated with a second semiconductor material.

27. The gain medium of claim 26, wherein each first semiconductor material has a first band gap and each second semiconductor material has a second band gap that is larger than the first band gap.

28. The gain medium of claim 23, each nanocrystal has a diameter of less than about 10 nanometers.

29. The gain medium of claim 23, wherein the plurality of nanocrystals have a monodisperse distribution of sizes.

30. A laser comprising:

an optical gain medium comprising a concentrated solid including a plurality of semiconductor nanocrystals; and

a cavity arranged relative to the optical gain medium to provide feedback.

31. The laser of claim 30, wherein the concentrated solid is substantially free of defects.

32. The laser of claim 30, further comprising an excitation source.

33. The laser of claim 32, wherein the excitation source is an optical source.

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34. The laser of claim 33, wherein each of the plurality of semiconductor nanocrystals includes a same or different first semiconductor material selected from the group consisting of a Group II-VI compound, a Group II-V compound, a Group III-VI compound, a Group III-V compound, a Group IV-VI compound, a Group I-III-VI compound, a Group II-IV-VI compound, and a Group II-IV-V compound.

35. The laser of claim 34, wherein each first semiconductor material is overcoated with a second semiconductor material.

36. The laser of claim 35, wherein each first semiconductor material has a first band gap and each second semiconductor material has a second band gap that is larger than the first band gap.

37. The laser of claim 30, wherein the plurality of nanocrystals have a monodisperse distribution of sizes.

38. A laser comprising:

an optical gain medium comprising a concentrated solid including a plurality of semiconductor nanocrystals; and

a microcavity arranged relative to the optical gain medium to provide feedback.

39. The laser of claim 38, wherein each of the plurality of semiconductor nanocrystals includes a same or different first semiconductor material selected from the group consisting of a Group II-VI compound, a Group II-V compound, a Group III-VI compound, a Group III-V compound, a Group IV-VI compound, a Group I-III-VI compound, a Group II-IV-VI compound, and a Group II-IV-V compound.

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40. The laser of claim 38, wherein each first semiconductor material is overcoated with a second semiconductor material.

Sub a 41. The laser of claim 40, wherein each first semiconductor material has a first band gap and each second semiconductor material has a second band gap that is larger than the first band gap.

42. The laser of claim 38, wherein the plurality of nanocrystals have a monodisperse distribution of sizes.

43. A laser comprising:

an optical gain medium comprising a concentrated solid including a plurality of semiconductor nanocrystals; and

a cavity arranged relative to the optical gain media to provide feedback, wherein the concentrated solid provides gain to an optical signal at an energy equal to or less than the maximum band gap emission of the nanocrystals.

44. The laser of claim 43, wherein each of the plurality of semiconductor nanocrystals includes a same or different first semiconductor material selected from the group consisting of a Group II-VI compound, a Group II-V compound, a Group III-VI compound, a Group III-V compound, a Group IV-VI compound, a Group I-III-VI compound, a Group II-IV-VI compound, and a Group II-IV-V compound.

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45. The laser of claim 43, wherein each first semiconductor material is overcoated with a second semiconductor material.

Sub D1 46. The laser of claim 45, wherein each first semiconductor material has a first band gap and each second semiconductor material has a second band gap that is larger than the first band gap.

47. The laser of claim 43, wherein the plurality of nanocrystals have a monodisperse distribution of sizes.

48. A gain medium comprising:

a concentrated solid including a plurality of semiconductor nanocrystals, wherein the

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concentrated solid is substantially free of defects, provides gain to an optical signal at an energy equal to or less than the maximum band gap emission of the nanocrystals, and is capable of providing gain at energies in which a concentrated solid is substantially free of absorption.

49. A method of amplifying an optical signal comprising:

directing an optical beam into a gain medium including a concentrated solid including a plurality of semiconductor nanocrystals, wherein the concentrate solid is substantially free of defects and provides gain to the optical signal at an energy equal to or less than the maximum band gap emission of the nanocrystals.

50. The method of claim 49, wherein each of the plurality of semiconductor nanocrystals includes a same or different first semiconductor material selected from the group consisting of a Group II-VI compound, a Group II-V compound, a Group III-VI compound, a Group III-V compound, a Group IV-VI compound, a Group I-III-VI compound, a Group II-IV-VI compound, and a Group II-IV-V compound.

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51. The method of claim 49, wherein each first semiconductor material is overcoated with a second semiconductor material.

52. The method of claim 49, wherein each first semiconductor material has a first band gap and each second semiconductor material has a second band gap that is larger than the first band gap.

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53. A method of forming a laser comprising:

arranging a cavity relative to a gain medium to provide feedback to the optical gain medium, wherein the optical gain medium comprises a concentrated solid including a plurality of semiconductor nanocrystals.

54. The method of claim 53, wherein each of the plurality of semiconductor nanocrystals includes a same or different first semiconductor material selected from the group consisting of a Group II-VI compound, a Group II-V compound, a Group III-VI

compound, a Group III-V compound, a Group IV-VI compound, a Group I-III-VI compound, a Group II-IV-VI compound, and a Group II-IV-V compound.

55. The method of claim 53, wherein each first semiconductor material is overcoated with a second semiconductor material.

56. The method of claim 53, wherein each first semiconductor material has a first band gap and each second semiconductor material has a second band gap that is larger than the first band gap.